IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of Vladimir S. MOXSON et al. Application No.: 10/748,619 Filed: December 27, 2003 For: FULLY-DENSE DISCONTINUOUSLY-REINFORCED TITANIUM MATRIX COMPOSITES AND METHOD FOR MANUFACTURING THE SAME	**MAIL STOP** **APPEAL BRIEF - PATENTS** Group Art Unit: 1734 Examiner: Weiping Zhu Appeal No.: ______________

APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This appeal is from the decision of the Primary Examiner dated January 19, 2011 finally rejecting claims 2, 3, 17, 19, and 21, which are reproduced as the Claims Appendix of this brief.

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The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§1.16, 1.17, and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800.

I. Real Party in Interest

The present application is assigned to Advance Materials Products, Inc., which is the real party in interest.

II. Related Appeals and Interferences

Neither the Appellants' legal representative nor the assignee knows of any other appeal or interferences which will affect or be directly affected by or have bearing on the Board's decision in the pending appeal.

III. Status of Claims

Claims 2, 3, 5-14, 17, 19, and 21 are pending in this application. Claims 5-14 have been withdrawn from consideration. Accordingly, each of claims 2, 3, 17, 19, and 21 has been finally rejected by the Office, which final rejection is appealed herein.

IV. Status of Amendments

No amendments were submitted after final rejection. A Notice of Appeal was submitted on March 17, 2011.

V. Summary Claimed Subject Matter

Claim 21 is directed to a fully-dense, discontinuously-reinforced titanium matrix composite material, which provides improved mechanical characteristics, such as toughness, flexural strength, impact strength, and wear resistance, and

provides essentially uniform structure of flat or shaped articles. The composite material comprises (a) a matrix of titanium or titanium alloy as a major component, (b) ceramic and/or intermetallic hard particles dispersed in the matrix in an amount of 50% by volume or less, and including particles of Al_8V_5, and (c) complex carbide- and/or silicide particles that are at least partially soluble in the matrix at the sintering or forging temperatures, such as $Ti_4Cr_3C_6$, Ti_3SiC_2, Cr_3C_2, Ti_3A1C_2, Ti_2AlC, Al_4C_3, Al_4SiC_4, $Al_4Si_2C_5$, Al_8SiC_7, V_2C, (Ti,V)C, VCr_2C_2, and $V_2Cr_4C_3$. The ceramic and/or intermetallic hard particles that are dispersed in the matrix are incorporated into the composite during preparation and before sintering of a powdered blend. The resulting composite is near-full density, and has acceptable mechanical properties without further hot deformation. Support for the claimed composite material can be found in the specification at page 5, lines 15-19 and lines 23-25; page 7, lines 25-30; and page 11, lines 15-18.

VI. Grounds of Rejection to be Reviewed on Appeal

The issue to be reviewed in this appeal is:

> Whether claims 2, 3, 17, 19, and 21 have been properly rejected under 35 U.S.C. § 103(a) as obvious over Brupbacher et al. in view of Gottselig et al. and in further view of Kugler.

VII. Argument

The Office action dated January 19, 2011 stated:

> With respect to claim 21, Brupbacher et al. (490) discloses a fully-dense discontinuously-reinforced titanium matrix composite material having superior physical and mechanical properties including high compressive properties, high fracture toughness and excellent creep characteristics comprising (col. 1, lines 25-43, col. 3, lines 23-58, col. 4 lines 3-50 and col. 4, line 63 to col. 5, line 8,

col. 7, line 3 to col. 9, line 49):

a. a matrix of a titanium alloy;

b. ceramic and/or intermetallic hard particles dispersed in the matrix comprising SiC, TiC, ZrC, TaC, WC, NbC and intermetallic compounds of various metals including Al, Ti, Si, Mo, W, Nb, V, Zr, Cr, Hf, Co Ni and Fe present as desired in the matrix;

c. complex carbide particles comprising Ti, Zr, Hf, V, Nb, Ta, Cr, Mo and W separately provided in a reaction mixture that are at least partially soluble in the matrix at the sintering or forging temperature such as TiVC dispersed in the matrix; and

d. complex carbide-aluminide particles such as TiVC/TiAl, suggesting the claimed complex carbide-aluminide particles of Al_4SiC_4, Al_4SiC_4 or Al4SiC4 would be formed in the presence of SiC and Al during the direct synthesis process of Brupbacher et al. (`490), wherein the ceramics and/or intermetallic hard particles dispersed in the matrix are incorporated into the titanium matrix composite during the preparation of a basic powdered blend (col. 1, lines 30-43 and Example 3)

Office action dated January 19, 2011 at pages 2-3. The Office admits to at least one defect in the disclosure of Brupbacher et al. with respect to Appellants' claims, and attempts to cure this deficiency by turning to the teachings of Gottseling et al.:

> Brupbacher et al. (`490) does not specify the presence of the complex carbidesilicide particles in the titanium matrix composite material as claimed. Gottselig et al. (`529) discloses forming Ti_3SiC_2 by reacting Ti with SiC (abstract). It would have been obvious to one of ordinary skill in the art that during the direct synthesis process of Brupbacher et al. (`490), the claimed $Ti_3SiC_2$ would be formed in the presence of SiC and Ti as evidenced by Gottselig et al. (`529) (abstract). Brupbacher et al. (`490) does not specify the amounts of the ceramic and/or intermetallic hard particles as claimed. However, Brupbacher et al. (`490) discloses that the total ceramic whisker loadings range from less than 5 to greater than 90 volume percents (col. 4, lines 3-10), which overlaps the claimed ranges of 50% by volume or less. A prima facie case of obviousness exists. See MPEP 2144.05 I.

Office action dated January 19, 2011 at pages 3-4. However, the Office recognizes that even this combination of references is insufficient to teach every feature of Appellants' claims, turning to Kugler et al:

> Brupbacher et al. (`490) in view of Gottselig et al. (`529) does not disclose the presence of the intermetallic compound of Al_8V_5in the titanium matrix composite material as claimed. However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to substitute the carbides of Brupbacher et al. (`490) in view of Gottselig et al. (`529) (e.g. TiC) with the claimed Al_8V_5 in the titanium matrix composite material of Brupbacher et al. (`490) in view of Gottselig et al. (`529) with an expectation of success, because the carbides and Al_8V_5 are functionally equivalent in terms of being used to make solid ceramic or intermetallic cathodes as disclosed by Kugler (`412) (col. 1, lines 34-40 and Example 2). See MPEP 2144.06.

Office action dated January 19, 2011 at page 4.

Despite having selectively combined the teachings of three different references, the Office recognizes that it still has not shown every feature recited in Appellants' claims, and thus turns to an inherency rationale:

> The properties of the fully-dense discontinuously-reinforced titanium matrix composite material disclosed by Brupbacher et al. (`490) appear to read on the properties as claimed in the instant claim 21. It would have been obvious to one of ordinary skill in the art that the mechanical and other properties of claimed and Brupbacher et al. (`490) in view of Gottselig et al. (`529) and further in view of Kugler (`412)'s discontinuously-reinforced titanium matrix composite materials would be similar because the similarities in compositions and processes of making between the materials.

Office action dated January 19, 2011 at page 4.

Appellants respectfully submit that the Office has failed to establish a prima facie case of obviousness of the rejected claims for the reasons given below.

The Office's primary reference, Brupbacher et al., is concerned with avoiding the problems that result when externally produced ceramic whiskers are used in metal ceramic composites. Brupbacher et al. provides a litany of such problems:

> Several difficulties are encountered in the production of conventional whisker reinforced composites. Externally produced whiskers are inevitably exposed to a certain amount of surface contamination during the whisker formation process and/or during subsequent handling steps. The surface contaminants, such as oxides, result in a deleterious layer or coating at the whisker-to-metal interface in the composite. Such layers inhibit interfacial bonding between the whiskers and the metal matrix, adversely affecting ductility of the composite. The weakened interfacial contact may also result in reduced strength, loss of elongation, and facilitated crack propagation. Additionally, the presence of surface contamination may inhibit wetting of the whiskers by molten matrix metal, rendering preparation of the composite difficult if not impossible. Consequently, many conventional whisker reinforced composites are not capable of being remelted, due to the tendency of the non-wetted whiskers to segregate from the molten matrix metal. Further, externally produced whiskers tend to agglomerate during powder blending steps, resulting in a non-uniform distribution of whiskers throughout the metal matrix. Also, at moderately high operating temperatures, conventional whiskers often deteriorate and/or react with the matrix metal.

Brupbacher et al., column 1, lines 44-68. Brupbacher et al. identifies other problems, such as lack of commercial availability of refractory whisker materials and potential health hazards associated with handling the whiskers. See Brupbacher et al. at column 2, lines 1-7. Brupbacher et al. also describes problems associated with molten metal infiltration of a continuous skeleton of preformed whisker material. These problems include those described above for externally produced whiskers as well as the need for molten metal handling and high pressure equipment. See Brupbacher et al. at column 2, lines 8-24.

Brupbacher et al. solves these problems by forming the whiskers in situ. Brupbacher et al. states:

> The present invention overcomes the disadvantages of the prior art noted above. More particularly, the present invention provides for a cleaner whisker/metal interface compared with conventional whisker reinforced composites made by techniques using preformed whiskers because the reinforcing whiskers are formed in situ. The clean whisker/metal interface achievable by the present invention results in highly improved mechanical properties.

Brupbacher et al. at column 2, lines 25-31. Brupbacher et al. also describes advantages such as improved stability at high temperatures, reduced costs of production, and simplified production procedures and equipment. See Brupbacher et al. at column 2, lines 31-43.

The Office alleges that Brupbacher et al. discloses a titanium matrix that contains the ceramic and/or intermetallic hard particles recited in element (b) of Appellants' claim 21, and at least partially soluble complex carbide and/or silicide particles of element (c) of claim 21. However, as explained above, Brupbacher et al. carbide whiskers, which may contain TiVC, one of the carbides recited in element (c) of claim 21. See Brupbacher et al. at column 4, line 68 to column 5, line 8. The Office does not identify where Brupbacher et al. disclose the presence of a second type of particle, namely the ceramic and/or intermetallic hard particles of element (b) of claim 21. As the Office appears to recognize, Brupbacher et al. also fails to disclose that this second type of particle should include particles of Al_8V_5.

The Office does not offer any cogent explanation of why one having ordinary skill in this art would include the ceramic and/or intermetallic hard particles of element (b) of claim 21 in a titanium matrix composite containing whiskers made from TiVC as disclosed in Brupbacher et al. Brupbacher et al. does not disclose any problem with either its composites or the prior art composites that would be solved by such a step. To the contrary, the litany of problems recognized by Brupbacher et

al. are solved by producing the carbide whiskers in situ, rather than preforming them. Appellants submit that such a disclosure does not suggest any problem that could plausibly be solved by including a different, preformed, ceramic or intermetallic particle the composite.

The Office, because it appears to want to map the whiskers of Brupbacher et al. to element (b) of claim 21, and thus must somehow find something in Brupbacher et al. to map to element (c) of claim 21, turns to Gottselig et al., apparently reasoning that somehow Gottselig et al. teaches that Ti_3SiC_2 will inherently form during sintering in the presence of SiC and Ti. The Office stated:

> The ground of rejection of the claimed titanium matrix composite relies on the teaching of Brupbacher et al. ('490) rather than that of Gottselig et al. ('529) and Gottselig et al. ('529) does teach the formation of Ti_3SiC_2 during sintering in the presence of SiC and Ti (abstract) . . . .

Office action dated January 19, 2011 at page 6.

First, Gottselig et al. does not appear to provide the broad teaching that the Office alleges. Gottselig et al. relates to adhering together SiC parts using a Ti_3SiC_2 adhesive layer. The abstract of Gottselig et al. upon which the Office specifically relies, states:

> The layer may be applied directly by a powder dispersion in a volatile but viscous glycol or by sputtering or else the layer can be made in place from a powder mixture of components, especially $TiC_{0,8}$ and $TiSi_2$ (5:1) or a titanium layer of a thickness in the range of 1 to 3 μm that reacts with the silicon carbide surface. When silicon carbide parts are joined together, the heating up to make the joint also serves to convert a titanium layer into titanium carbosilicide. When silicon carbide is to be joined with metal, a preliminary heating step is necessary to at first convert a powder mixture or a titanium layer on the silicon carbide surface to Ti_3SiC_2. . . . The heating requires reaching a temperature in the region of 1200 ° to 1600 °C. for periods between a half hour to about three hours in the presence of a reducing protective gas.

Gottselig et al., abstract. This is a far cry from a statement that, whenever a titanium metal and silicon carbide are sintered, particles of Ti_3SiC_2 necessarily form.

Second, as is apparent from the portion of Gottselig et al. quoted above, Gottselig et al. is drawn from the field of endeavor of joining SiC bodies together by forming a ceramic braze or joint. Gottselig et al. is not drawn from the field of endeavor of making ceramic whisker reinforced titanium matrix composites, as is Brupbacher et al. Of the litany of problems described by Brupbacher et al., the Office has not identified a single problem that is also solved by Gottselig et al. Under these circumstances, the Office has not shown that Gottselig et al. is not directed to a problem "known in the field of endeavor" of Brupbacher et al. As a result, Gottselig et al. does not deal with matter that, "logically would have commended itself to an inventor's attention in considering his or her invention as a whole." MPEP § 2141.01(a)(I). Applying the somewhat more useful test for nonanalogous subject matter set forth in *In re Wood*, 202 USPQ 171, 174 (CCPA 1979) (which, to Appellant's knowledge, has not been overruled by *KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, 82 USPQ2d 1385, 1397 (2007)), Appellants submit that Gottselig et al. is not drawn from the same field of endeavor as that of Brupbacher et al. (or that of Appellants), and is not directed to solving any of the problems addressed by Brupbacher et al. (or by Appellants), and is therefore non-analogous art.

Third, it is unclear where the Office finds in Brupbacher et al. a disclosure of the presence of both SiC and titanium metal. Appellants have carefully reviewed the boride and carbide ceramic whiskers listed at column 3, lines 2-8, but have been unable to locate any mention of SiC. Similarly, the examples of Brupbacher et al. are devoid of any mention of SiC. Similarly, Appellants have been unable to find any

mention in Brupbacher et al. of the sintering conditions disclosed to be necessary in the Abstract of Gottselig et al. for Ti_3SiC_2 to form. If neither SiC nor the requisite sintering conditions are disclosed to be present in the Brupbacher et al. then there is no basis (other than unsupported speculation) for assuming that Ti_3SiC_2 would have formed in the composite of Brupbacher et al. Yet, considerably more than unsupported speculation is necessary in order to reach a conclusion of inherency in an obviousness rejection, as even the MPEP recognizes:

> Obviousness cannot be predicated on what is not known at the time an invention is made, even if the inherency of a certain feature is later established. *In re Rijckaert*, 9 F.3d 1531, 28 USPQ2d 1955 (Fed. Cir. 1993). See MPEP § 2112 for the requirements of rejections based on inherency.

MPEP § 2141.02(V).

> The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert,* 9 F.3d 1531, 28 USPQ 1955, 1957 (Fed. Cir. 1993) (reversed rejection because inherency was based on what would result due to optimization of conditions, not what was necessarily present in the prior art); *In re Oelrich*, 666 F.2d 578, 581-82, 212 USPQ 323, 326 (CCPA 1981). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'" *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999) (citations omitted) . . . .

MPEP § 2112(IV). The relevant case law, as interpreted by the Office in the MPEP, makes fairly clear that it is inappropriate to rely on a theory that Ti_3SiC_2 would inherently form in a material that is not disclosed to contain the necessary precursors and that is not disclosed to have been subjected to the necessary processing

conditions, all as explicitly disclosed to be needed by the Office's own secondary reference.

Because the Office's inherency rationale is without any justification in the record, there is no rational basis for concluding that particles of Ti_3SiC_2 are present in the composite of Brupbacher et al. Because there is thus no disclosure or suggestion of such particles in Brupbacher et al., there is no disclosure there of two different particles as recited in elements (b) and (c) of Appellants' claim 21.

The Office, while failing to acknowledge the failure of Brupbacher et al. to disclose the presence of a second particle at all, apparently does recognize the failure of Brupbacher et al. to disclose that the second particle should be Al_8V_5. In an attempt to cure this deficiency, the Office turns to Kugler. The Office apparently reasons that Kugler discloses that Al_8V_5 is equivalent to TiC, and that this somehow justifies (a) adding an additional particle to the composite of Brupbacher et al. that (b) includes Al_8V_5. The Office states:

> The ground of rejection of the claimed titanium matrix composite relies on the teaching of of Brupbacher et al. ('490) rather than that of Kugler ('412). Kugler ('412) does teach that the carbides of Brupbacher et al. ('490) in view of Gottselig et al. ('529) (e.g. TiC) and Al_8V_5 are functionally equivalent (col. 1, lines 34-40 and Example 2), therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to substitute the carbides of Brupbacher et al. ('490) in view of Gottselig et al. ('529) (e.g. TiC) with the claimed Al_8V_5 in the titanium matrix composite material of Brupbacher et al. ('490) in view of Gottselig et al. ('529) with an expectation of success.

Office action dated January 19, 2011 at page 6.

Kugler relates to cathodes for electrolytice cells, not to titanium matrix composites, and not to adhesives for bonding SiC bodies together. Kugler is drawn

from a different field of endeavor from that of either Brupbacher et al. or Gottselig et al. Moreover, Kugler is directed to the problem of developing:

> an exchangeable solid cathode which can be made using simple technology, exhibits a lower degree of brittleness and yet satisfies all the economic and technical requirements of the modern aluminum electrolytic reduction process.

Kugler at column 2, lines 21-24. These problems are different from those addressed by either Brupbacher et al. or Gottselig et al., and are unrelated to the fields of endeavor of those references. Accordingly, Appellants submit that Kugler is drawn from an art area that is not analogous to that of the other references, and is thus not properly combinable with them.

In addition, even if Kugler were properly combinable with the other cited references, it is not clear where Kugler teaches the equivalency alleged by the Office, or how any such alleged equivalency is relevant to the material disclosed in Brupbacher et al. Kugler mentions Al_8V_5 as part of a combination with VAl_3 in an aluminide cathode in a table at column 4, lines 45-60. Kugler states:

> Cathode elements for the aluminum electrolytic process can be made from other aluminide in a manner similar to that used to make titanium aluminide cathodes:

Kugler at column 4, lines 46-50. Rather than disclose any equivalence between TiC and Al_8V_5, as alleged by the Office, Kugler at best suggests that Al_8V_5 may be used, in combination with VAl_3 as a replacement for $TiAl_3$ as a cathode element for use in an aluminum electrolytic process. This is a far cry from disclosing a general equivalency between Al_8V_5 and TiC. First, TiC does not appear to be even mentioned in Kugler.

Second, even if TiC was mentioned in Kugler and was mentioned in a way that provided some meaningful, reasonable expectation that it was a replacement for

Al_8V_5 (rather than for a combination Al_8V_5 and $TiAl_3$), any such "equivalence" would be in the context of a cathode for an aluminum electrolytic process. The Office has not explained how or why the facts of record in this application would lead to the conclusion that one having ordinary skill in the cathode art would extrapolate such an "equivalence" to the different field of endeavor of titanium matrix whisker composite materials. Conversely, the Office has provided no explanation of why a worker having ordinary skill in the art of titanium matrix composites would (a) look to a reference relating to cathode materials and (b) conclude from the disclosure of Al_8V_5 combined with $TiAl_3$ as a suitable cathode material that Al_8V_5 should be added to the composite of Brupbacher et al. The Office has also not explained how it knows that introducing Al_8V_5 into the composite system of Brupbacher et al. will have any beneficial effect thereon and will not have a detrimental effect on the ability of the composite of Brupbacher et al. to meet its goals.

In summary, the Office's rejection is based on an incorrect understanding of the disclosure of Kugler, an incorrect application of the principles of inherency in an obviousness rejection, and insufficient reasoning for combining the reference teachings. For at least the reasons given above, Appellants submit that the Office has failed to establish a prima facie case of obviousness, and has made reversible error by rejecting the claims. Reversal of this erroneous rejection is respectfully requested.

VIII. Claims Appendix

See attached Claims Appendix for a copy of the claims involved in the appeal.

IX. Evidence Appendix

See attached Evidence Appendix for copies of evidence relied upon by Appellant.

X. Related Proceedings Appendix

See attached Related Proceedings Appendix for copies of decisions identified in Section II, supra.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date May 3, 2011

By: ______________________

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VIII. CLAIMS APPENDIX

The Appealed Claims

2. The fully-dense discontinuously-reinforced titanium matrix composite material according to claim 21 is characterized by discontinuous porosity at the density over 98% from the theoretical value.

3. The fully-dense discontinuously-reinforced titanium matrix composite material according to claim 21, wherein the matrix alloy is selected from a-titanium alloys, (a+β)-titanium alloys, β-titanium alloys, and titanium aluminide alloys.

17. The fully-dense discontinuously-reinforced titanium matrix composite material according to claim 21, wherein graphite hard particles and hard particles of silicon carbide SiC are added in amount of 40% or less of the total amount of said hard particles dispersed in the titanium matrix.

19. The fully-dense discontinuously-reinforced titanium matrix composite material according to claim 21, wherein said complex carbide-silicide and carbide-aluminide hard particles are dispersed in the matrix in the amount of about 20% by volume and at least partially soluble in the matrix at sintering and forging temperatures.

21. A fully-dense discontinuously-reinforced titanium matrix composite material to provide improved mechanical characteristics such as toughness, flexure strength, impact strength, and wear resistance, as well as essentially uniform structure of flat and shaped articles, comprising

(a) a matrix of titanium or titanium alloy as a major component,

(b) ceramic and/or intermetallic hard particles dispersed in the matrix in the amount of 50% by volume or less include particles of Al_8V_5 compound, and

(c) complex carbide- and/or silicide particles that are at least partially soluble in the matrix at the sintering or forging temperatures such as $Ti_4Cr_3C_6$, Ti_3SiC_2, Cr_3C_2, Ti_3A1C_2, Ti_2AlC, Al_4C_3, Al_4SiC_4, $Al_4Si_2C_5$, Al_8SiC_7, V_2C, (Ti,V)C, VCr_2C_2, and $V_2Cr_4C_3$, wherein

the ceramic and/or intermetallic hard particles dispersed in the matrix are incorporated into the titanium matrix composite during the preparation and before sintering of a basic powdered blend to produce near-full density parts from a titanium matrix composite material that has acceptable mechanical properties without a need for further hot deformation.

IX. EVIDENCE APPENDIX

None

X. RELATED PROCEEDINGS APPENDIX

None